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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
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Letter
Circular
LC-297

ELECTRIC AND GAS REFRIGERATORS

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(Replaces LC-255)

This letter circular has been prepared to serve as a reply to the numerous requests received by the Bureau of Standards for information on household refrigerators. Many of these requests are for recommendations or opinions on specific makes of machines, or for results of tests made by the Bureau. It can be stated at once that it is not one of the functions of the Bureau to collect or distribute information on the relative merits of commercial products, and that it neither gives opinions nor makes recommendations concerning them. Only a very few tests of refrigerators have been made by the Bureau to determine compliance with special requirements of other government departments. The latest tests were made several years ago, so that the results are not applicable to machines now being sold.

This letter circular deals with the type of machine which is complete in itself, and statements made here may not be applicable to the so-called multiple systems installed in many apartment houses, in which a number of refrigerators are connected to a single compressor.

There are two general types of refrigerating systems, the compression and the absorption type. The compression type consists essentially of three parts, a cooling unit, which is inside the refrigerator, and a motor driven compressor and a condenser outside. If the machine has been running and is then shut down, there will ordinarily be some liquid refrigerant in the condenser under high pressure, and some in the cooling unit at lower pressure. As the refrigerator and cooling unit become warmer, an automatic switch starts the motor. The compressor then removes vapor from the cooling unit, so that the liquid therein can evaporate at low pressure and temperature, and thus effect cooling. The compressor, taking the vapor

from the cooling unit at low pressure, must compress it to a pressure sufficiently high to cause liquefaction in the condenser, from which heat is removed either by water or by air. The liquid from the condenser then passes through an expansion valve or equivalent device, to the cooling unit, so that the operation is continuous as long as the motor runs. When the cooling unit and refrigerator have cooled sufficiently, an automatic switch stops the motor.

In the absorption type the vapor from the cooling unit is absorbed in a suitable substance, such as water, or other liquid, or by a solid which is capable of absorbing large quantities of vapor. Subsequently, the substance containing the absorbed vapor is heated, either electrically or by a gas flame, and the vapor is driven off, then cooled and condensed to a liquid, which is returned to the cooling unit. Machines of this type have few or no moving parts, practically all of them are almost noiseless in operation but in contrast with many machines of the compression type, require connection to a water supply for cooling. Some of the machines using a liquid absorber are continuous in operation, the heat being applied always to one part, while the liquid is caused to circulate. Others are of the intermittent type, the heat being supplied for a time to one part, then to another part, or to one part at intervals.

Nearly all of the machines now on the market are designed to provide for freezing ice cubes, and since this feature is so very generally included, no further consideration of it is required here.

A very large number of makes of refrigerating machines of the compression type have been put on the market. These have included such variations as direct drive, belt drive, and gear drive; reciprocating single or multiple cylinder compressors, various types of rotary compressors; various refrigerants such as sulfur dioxide, methyl chloride, ethyl chloride, ammonia, volatile hydrocarbons, etc.; air or water cooling; refrigeration by direct expansion or by the use of brine tanks, etc. New patented refrigerants intended to reduce the hazards resulting from accidental escape of the refrigerant from the machine have recently become available. Completely sealed machines of the compression type have also been made. It is impracticable to dis-

cuss here the various merits and demerits of the features which are often emphasized out of all proportion to their importance, in advertising and by salesmen. The user of a machine is not so much concerned with the kind of drive, refrigerant or absorbent used, type of compressor or system of refrigeration as he is in the kind of service the machine will give and what the service may cost over a period of years. For example, there is no outstanding advantage in a machine with a brine tank as compared with one of the direct expansion type, but the success or failure of either will depend upon the quality of the whole machine and not upon such a detail of design.

Knowledge of details of design of this kind is of value to the expert in judging whether the machine is designed and made so that it can be expected to have a reasonably long life and give satisfactory service during its life. The fact that a machine has one or several features of design which seem superior does not necessarily indicate that it will prove to be superior to other machines having other features of design. For example, the refrigerant used is a factor of minor importance as regards efficiency, since machines can be designed to use any of the ordinary refrigerants effectively. Similarly either compression or absorption machines can give very satisfactory service.

There have been instances where refrigerants which constituted a distinct hazard to life or health have been used, but such hazards are very remote for any of the self-contained units now on the market. Again a poorly designed machine might introduce a distinct fire or accident hazard.

Short time tests of refrigerating machines unfortunately furnish only incomplete information as to their relative merits. Such a test may disclose obvious defects and will readily show the power or gas and water consumption and the efficiency of the unit tested, when new. By operating the machine under extreme conditions, for example, at high room temperatures, it is possible to make an estimate of the margin of reserve in power, cooling capacity and strength of parts above ordinary requirements, but none of these tests gives information on the most important points, namely, the durability

and reliability in service of the average machine under ordinary conditions.

Some of the factors to which the prospective purchaser of a machine should give attention are the following:

1. Standing of the manufacturer. If the manufacturer does not remain in business the machine is likely to become obsolete in a very short time, since replacement of worn or defective parts may be difficult or impossible.

2. Record of the machine. A machine in the experimental or development stage is a more speculative proposition than one which has stood the test of service.

3. Noise. Unless a machine runs quietly when new and continues to do so, it will be unsatisfactory to most of its users.

4. Useful life. The aggregate cost of refrigeration depends to a considerable extent upon the length of life of the machine, and upon the cost of service and repairs. Very little information on this point is available, and the purchaser must depend upon the reputation of the product and such information as he can find in regard to durability.

5. Efficiency of the machine. There are considerable differences in the operating efficiencies of different machines, and figures on operating costs can sometimes be obtained. If a machine is not well made or is allowed to deteriorate, efficiency may be greatly reduced after a short period of use.

6. Insulation of the refrigerator. The refrigerator should be well insulated, preferably with not less than a two-inch thickness of some good insulating material. Refrigerators depending largely upon ordinary air spaces for insulation or those with thin walls and doors are likely to require considerable power or fuel and water to keep them cold.

7. Air or water cooling. If the machine is water cooled, the purchaser should determine that the water supply is suitable for the purpose, so that deposits from hard water will not be formed inside the machine, ultimately interfering with its functioning, and that the water supply is sufficient in quantity and not too expensive.

8. Servicing of machine. Preference should be given to a machine which could be easily and inexpensively serviced or repaired when necessary. A machine which could easily be removed entirely and replaced by another would be classed as easily serviced. If attention such as oiling or adjustments are required from time to time, the points requiring attention should be few in number, and should be readily accessible where the machine is to be installed, lest it suffer from neglect.

9. Quality of local service. A machine obtained from a responsible dealer who is prepared to attend to adjustments and repairs promptly when required, is to be preferred.

Comparison of Refrigeration by Machines and by Ice.

The purpose of this section is not to make an exhaustive comparison between machine refrigeration and ice refrigeration but merely to point out some of the more obvious facts, which if kept in mind, may enable the prospective purchaser to avoid being puzzled or misled.

The owner of a refrigerating machine is free from whatever annoyance accompanies frequent or irregular delivery of ice, although he is subject to inconvenience in case the machine is out of service for repairs, etc., or on occasions when the supply of ice cubes is inadequate. The machine can be set to maintain a lower temperature than is practicable with ice, so that left overs can be kept a somewhat longer time before being thrown away. Few subjects are more misunderstood by the public and by writers on refrigeration than that of temperatures required for proper refrigeration. Many writers draw a dead line at 50°F and state in effect, that useful refrigeration is not obtained above that temperature. The facts are, however, fairly simple and obvious. Time and temperature are equally essential factors in decay. Most foods will remain palatable and wholesome if kept as long as a day or two at a temperature as high as 60°F. If they are to be kept for a week, 50°F may not be low enough. If they are to be kept for a month, the temperature must be still lower. In any case, most users prefer to serve food while it is fresh; there are very few who purchase a refrigerator for the purpose of establishing a miniature cold storage plant to preserve foods for considerable periods, and the possibility of keeping foods for more than a

limited time is of little practical importance. There is, of course, a wide difference in the keeping qualities of various kinds of foods. The user of a machine is usually less subject to loss from spoilage of food, and in some cases there may be a considerable saving in this respect.

Either an ice cooled refrigerator or a machine cooled refrigerator tends to maintain a dry atmosphere in the food compartments and thus to dry out moist materials stored in them. The water from the melted ice carries off material in solution thereby removing causes of odors.

In comparing refrigeration by use of ice and by use of a small machine, it is obvious that the relatively large plant which makes ice is likely to be much more efficient than the small machine can be expected to be. After the ice has been made, however, it must still be distributed to the user at considerable expense. It does not follow therefore that refrigeration by ice will necessarily be cheaper than by machine. Within the past few years the first cost of machines has been decreased, their reliability has been improved, and in many localities the cost of electric power or of gas and water is low enough to make the total cost of refrigeration by machine as low as, or possibly lower than, the cost of refrigeration with ice. The user of a machine is in general subject to fewer inconveniences than the user of ice, and it is possible to maintain lower temperatures with the machine, so that on the whole a good machine gives better service.

The relative cost of refrigeration with ice and with a machine depends very largely upon the useful life of the machine and the costs of repairs, replacements and service. To make a comparison of costs, it is necessary to estimate the probable life of the machine and then to estimate operating costs, and costs of repairs, service, etc., over this period. To these add the initial cost, (including interest charges if desired) and divide the total by the number of years to find the aggregate cost of refrigeration per year. A similar estimate may be made for a refrigerator using ice. Such computations indicate that a machine should have a useful life of at least ten years in order that the cost of refrigeration by machine should not be unduly high as compared with ice refrigeration.

Other Sources of Information:

1. "Household Refrigeration", 3rd Revised Edition, by H. B. Hull, published by Nickerson and Collins Co., Chicago, 1927 - 488 pages $3.50

2. A report of the Refrigeration-By-Gas Committee of the American Gas Association (1925), 342 Madison Avenue, New York, N. Y.

3. A report of the Electric Refrigeration Committee of the National Electric Light Association (1924-25) 29 West 39th Street, New York, N. Y...$0.80

4. A booklet entitled "Home Economics Bibliography 5 - Household Refrigeration". This booklet containing a list of references to articles, mostly non-technical, of interest to the householder may be obtained free from the Bureau of Home Economics, Department of Agriculture, Washington, D. C.

5. The Household Refrigeration Bureau of the National Association of Ice Industries, Chicago, Ill., issues pamphlets on household refrigeration and related subjects.

Numerous papers on this subject may be found in the refrigeration journals listed below:

Journal	Published	Publisher	Address
Refrigerating Engineering	Monthly	Am. Soc. of Refrig. Engrs.	37 W. 39th St.,N.Y.C.
Refrigerating World	Monthly	The Ice Trade Journal Co.	Woolworth Bldg.,N.Y.C.
Ice & Refrigeration	Monthly	Nickerson & Collins Co.	5707 W.Lake St.,Chicago.
Electric Refrigeration News	Bi-weekly	Business News Publishing Co.	554 Maccabees Bldg., Detroit, Mich.

This letter circular has been prepared for the purpose of answering individual inquiries only, and it is not to be used in connection with advertising or sales promotion.